REMARKS/ARGUMENTS

This Amendment is responsive to the Office Action mailed on November 24, 2003. Claims 10 and 19 are canceled, and the limitations therein are respectively incorporated into independent claims 6 and 13. After entry of this Amendment, claims 6-9, 11 and 13-18 would be pending and subject to examination. This Amendment is being filed with an RCE (request for continued examination).

35 USC 103 - Schnur et al., ASM, and Porterfield

Claims 6-8 and 10 are rejected as obvious over Schnur et al., ASM (ASM Handbook Vol. 5, Surface Engineering), and Porterfield (basic textbook on inorganic chemistry).

As argued in prior Amendments, one skilled in the art would not have been motivated to have modified Schnur et al. with the teachings of ASM, because the cited references explicitly teach away from each other. Applicants also previously argued that one skilled in the art would not have chosen ASM's copper-tin colloid catalyst instead of Schnur et al.'s Pd/Sn catalyst, because doing so (1) would be a "major disadvantage," (2) would result in a "much less stable solution," (3) would result in "process control problems," and (4) would take away a "principal feature" of Schnur et al.'s invention. Furthermore, Applicants argued that because of the process control problems and poor catalytic ability of ASM's copper-tin colloidal catalyst, the Office Action's proposed substitution of ASM's copper-tin colloidal catalyst for Schnur et al.'s palladium-tin catalyst would also likely not have resulted in the fine microcircuits desired by Schnur et al. Applicants' prior arguments are incorporated herein.

In response to Applicants' arguments, the Office Action states that ASM Handbook "suggests the proposed modification to save money and that copper-based catalysts have been proven commercially successful."

Applicants note the Office Action's argument, but respectfully submit that the ASM Handbook, and Schnur et al. must be viewed "as a whole" and without looking at Applicants' disclosure when arriving at the obviousness determination. A prior art reference must be considered in its entirety, i.e., as a whole, *including portions that would lead away from the*

claimed invention. W.L. Gore & Associates, Inc. v. Garlock, Inc., 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984). As explained at MPEP 2142,

> To reach a proper determination under 35 U.S.C. 103, the examiner must step backward in time and into the shoes worn by the hypothetical "person of ordinary skill in the art" when the invention was unknown and just before it was made. In view of all factual information, the examiner must then make a determination whether the claimed invention "as a whole" would have been obvious at that time to that person. Knowledge of applicant's disclosure must be put aside in reaching this determination, yet kept in mind in order to determine the "differences," conduct the search and evaluate the "subject matter as a whole" of the invention. The tendency to resort to "hindsight" based upon applicant's disclosure is often difficult to avoid due to the very nature of the examination process. However, impermissible hindsight must be avoided and the legal conclusion must be reached on the basis of the facts gleaned from the prior art.

Applicants have provided at least four strong reasons why one skilled in the art would not have been led to combine the references in the manner provided by the Office Action, even if the Office Action can provide one reason why one skilled in the art may have tried to modify Schnur et al. When viewing the cited references "as a whole", it is respectfully submitted that when the four strong reasons against their combination are viewed against the alleged one reason for their combination, the skilled artisan would not have been made the combination proposed by the Office Action.

To expedite the prosecution, independent claim 6 now recites "wherein the diffusion barrier is capable of preventing the diffusion of copper atoms from the metal layer into the substrate when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm at 200 °C in flowing N_2". Independent claim 13 recites "wherein the device does not exhibit $j_{leakage} > 1000\ nAcm^{-2}$ when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm in flowing N_2 at 200 °C for up to 650 minutes." These barrier layer properties are not taught or suggested by Schnur et al. While the Office Action suggests at pages 5-6 of the Office Action that properties such as these are "inherent," Applicants respectfully submit that Applicants' data at FIG. 3 of the present

application shows that different molecules show different barrier layer properties. This data shows that not all molecules in all SAM barrier layers have identical properties.

To further support Applicants' arguments, attached hereto is the Declaration of G. Ramanath, a co-inventor in the present application. As indicated in the Declaration, Dr. Ramanth is an expert in the field and is one of skill in the art. As stated by Dr. Ramanath (citations omitted below):

> 4. Independent claim 6 recites "wherein the diffusion barrier is capable of preventing the diffusion of copper atoms from the metal layer into the substrate when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm at 200 °C in flowing N_2". Independent claim 13 recites "wherein the device does not exhibit $j_{leakage} > 1000$ nAcm^{-2} when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm in flowing N_2 at 200 °C for up to 650 minutes." Variants of capacitance-voltage (C-V), current-voltage (I-V), C-t, or I-t testing carried out under conditions similar to those mentioned above..., or measurement of metal incorporation by spectroscopic depth profiling, e.g., of samples annealed to higher temperatures (e.g., 500-700 °C) without an electrical bias..., are commonly accepted benchmarks for evaluating the diffusion barrier properties of interfacial layers between copper, and dielectric or seminconductor materials.... Works related to this area in the literature explicitly qualify the efficacy of diffusion barrier properties based on such tests. In this context, I believe that these barrier layer properties are not taught or suggested by Schnur et al., either expressly or inherently. While the Office Action suggests at pages 5-6 of the Office Action that properties such as these are "inherent", Applicants' data in FIG. 3 of the present application show that different molecules exhibit different barrier layer properties. Accordingly, contrary to the Office Action's allegation, I believe that it cannot be presumed that the properties recited in the claims are "inherent".
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> 5. At page 4 of the Office Action, the Office Action cites Example 24 and the statement that diffusion of copper was not a problem. However, the molecule used to form a monomolecular film in Example 24 is the same molecule that is used in Example 1, namely, octenyldimethylchlorosilane. This molecule does not have an aromatic group. Applicants have shown, with experimental data, that SAMs with molecules with aromatic groups have better barrier layer properties than SAMs without molecules with aromatic groups.
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> 6. The Office Action also relies on Example 28 which mentions trichloro(4-pyridyl)-ethyl-silane. However, this molecule was deposited on a glass slide, and not on a semiconductor substrate. No device was formed so the

limitations "wherein the diffusion barrier is capable of preventing the diffusion of copper atoms from the metal layer into the substrate when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm at 200 °C in flowing N_2" as in independent claim 6 and "wherein the device does not exhibit $j_{leakage} > 1000$ $nAcm^{-2}$ when the semiconductor device is exposed to thermal annealing at 200 °C or an electric field of 2 MV/cm in flowing N_2 at 200 °C for up to 650 minutes" as in independent claim 13 cannot be inherent in Schnur et al.

Contrary to the Office Action's position and as indicated in the Ramanth Declaration, the barrier layers properties recited in the claims are not inherent in Schnur et al. Accordingly, withdrawal of the rejections is requested.

35 USC 103 - Schnur et al., ASM, Porterfield, and Wolf

Claims 9, 11, and 13-19 are rejected as obvious over Schnur et al., ASM, Porterfield, and Wolf.

Initially, Applicants submit that the combination of Schnur et al., ASM, and Porterfield is improper for the reasons stated above, and the arguments above are incorporated herein. The additional citation of Wolf does not cure the deficient combination of Schnur et al., ASM, and Porterfield.

In Applicants' previous Amendment, Applicants provided a number of reasons why the specific combination of Wolf and Schnur et al. is particularly improper. Those reasons are incorporated herein by reference.

It is believed that the Office Action's response to Applicants' arguments can be found at page 10-11 of the Office Action, where the Office Action relies on the "product-by-process" case law. In short, the Office Action appears to believe that the term "vapor deposition" is not entitled to patentable weight, since it is a process step in a device claim.

Previously, to rebut the inference that process limitations are not entitled to patentable weight, Applicants submitted an article by Yin et al. (Mater. Phys. Mech. 4 (2001) 56-61) to show that there are non-obvious structural differences in a layer deposited by electroless plating (see page 56) and by a vapor deposition process. However, in response to the citation of Yin et

al., the Office Action states that the "article is not germane to the instant case, because the metal being deposited is a Fe-Ni alloy -- copper. Moreover, the film is not being deposited on the given seed layer. Absent evidence that sputter deposited copper films and electroplated copper films on the Schnur barrier layer are different, the evidence will not be considered persuasive."

In response to the Office Action's request, Applicants are providing additional evidence supporting Applicants' contention that the Yin et al. article is sufficient to rebut the Office Action's presumption that the process limitations in the claims are entitled to patentable weight. At paragraph 7 of the Ramanath Declaration, Dr. Ramanath states (citations omitted below):

> 7. At pages 10-11 of the Office Action, the Office Action rejects claims reciting "vapor deposition" or the like by alleging that they are process limitations and that such limitations are not entitled to patentable weight. I have reviewed the article by Yin et al. (Mater. Phys. Mech. 4 (2001) 56-61) and Yin et al. shows that there are non-obvious structural differences in a layer deposited by an electroless plating process and by a vapor deposition process. As shown by FIG. 3 of Yin et al., SEM micrograph c) shows a film formed by vapor deposition, whereas SEM a) shows a film formed by an electroless plating process. As shown, the deposited films have a distinct structural difference, and as noted by page 58, second column of Yin et al., "the vapor phase deposition seemed to show a rougher surface as compared to other processes." Yin shows that electroless plated layers have a different microstructure than vapor deposited layers. Although Yin et al. discusses an Fe-Ni alloy, it is common knowledge (e.g., to materials scientists and crystal growers) that film microstructure is often a strong function of not only the deposition method, but also the deposition conditions. For example, in the case of copper films, it is known that ... the microstructure of sputter-deposited films have dramatically different microstructures compared to electroplated films. The same general principle applies to films deposited by other means, e.g., chemical vapor deposition..., ion plating ..., electroless plating, or by solid-state methods.... The microstructure in turn has a major influence on not only the properties (e.g., smaller grain size usually implies lower electrical conductivity) of the film, but also those related to the adjacent layers and interfaces (e.g., electromigration resistance, adhesion).... I believe that a vapor deposited layer as in the present claims would generally have a different microstructure, and hence properties, than the electroless metal layer in Schnur, since two different deposition mechanisms are used. Thus, contrary to the Office Action's statement, I believe that the Yin et al. article supports the argument that vapor deposited films generally have different microstructures than electroless layers.

Thus, Applicants have provided evidence that shows that a non-obvious "structural" difference is present in the claims reciting "vapor deposition" as compared to the electroless layers described in Schnur et al. The burden has now shifted back to the PTO to provide a reason why one would have modified Schnur et al. to include a vapor deposited layer.

The Office Action also states that the "inventive feature of the instant invention is the use of the self-assembled monolayer as a barrier layer. The manner in which the copper is depositing has not been indicated as critical to the instant invention and is not considered novel. ... Schnur discloses the exact same barrier layer as is presently being claimed."

In view of this statement, the PTO may believe that it is permissible to ignore or give less weight to claim limitations that are not "critical" to the invention or go to the perceived "gist" of the invention. However, this is prohibited by MPEP 2141.02, which states:

> In determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983) ....
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> DISTILLING THE INVENTION DOWN TO A "GIST" OR "THRUST" OF AN INVENTION DISREGARDS "AS A WHOLE" REQUIREMENT
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> Distilling an invention down to the "gist" or "thrust" of an invention disregards the requirement of analyzing the subject matter "as a whole." *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983)...

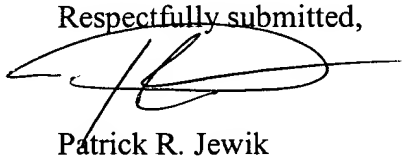
By alleging that the "inventive feature of the instant invention is the use of the self-assembled monolayer as a barrier layer. The manner in which the copper is depositing has not been indicated as critical to the instant invention and is not considered novel", the Office Action has essentially done what is prohibited by the MPEP. That is, claim limitations such as "vapor deposition" have been disregarded or discounted in the obviousness analysis, and the Office Action has focused on the perceived "gist" of the invention and has rejected the claims based on this perception. Applicants submit that the claimed combinations define the invention, not the specification or a single claim element. Since the claims have not been considered "as a whole" by the Office Action, Applicants submit that the obviousness rejection is improper.

Lastly, the Office Action has maintained his position that the "vapor deposition" process and Schnur's selective electroless plating process are "art recognized equivalents" and that the substitutions for each other would have been obvious. Applicants argued that Schnur specifically indicates that vapor deposition processes are not art recognized equivalent processes, since one process blankets the entire surface of a substrate and the other selectively deposits metal. Applicants also indicated at page 10 of the September 11, 2003 Amendment that "**Should the Examiner maintain that it is "obvious" to create a selectively deposited metal pattern like Schnur et al.'s (i.e., without lithography and etching) using a vapor deposition process that coats an entire substrate, Applicants request an explanation as to how this might be done as it is not apparent from the cited prior art.**" However, while the Office Action notes this argument (see page 10 of the Office Action), the Office Action discusses the product-by-process case law, yet maintains the "art recognized equivalents" rationale in the rejection. Accordingly, Applicants presume that the Office Action's "art recognized equivalents" rationale is still applicable and Applicants request that all of Applicants arguments be considered and a response provided (See MPEP 707(f) - Answer all material traversed).

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance.

Respectfully submitted,



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